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Senior High School

C U R R I C U L U M G U I D E

METALWORK 10 - 21 - 20 - 30
(Interim Edition, September, 1954)

Province of Alberta
Department of Education

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COURSE CREDIT VALUES

METALWORK 10 - 4 or 5 credits

METALWORK 20 - 8 or 10 credits

METALWORK 30 - 10 or 15 credits

METALWORK 21 - 4 or 5 credits

GENERAL INFORMATION

Course Organization

It is recommended that in all metal courses the available time be apportioned approximately as follows: -

Shop Practice - - - 60%

Theory - - - - - - 20%

Drafting - - - - - 20%

Safety Program

Every shop must have an effective safety program. In the metalworking shops particular emphasis must be given to the correct procedures for safe operation of machines and equipment.

A good safety program features the following devices: regular, consistent and thorough instruction: constant vigilance and checking by instructor; safety posters; student safety committee; adequate first-aid equipment; instructor trained and up-to-date in first-aid methods; dynamic color painting of machines and equipment; adequate working space about machines; safety lines on floor around machines; routine report on accidents however minor; machines and tools in approved working condition; a safety conscious group of students and instructor, etc.

Instructors' Records

The instructor should keep accurate records of:

student enrolment and attendance
student accounts
theory covered
student achievement - projects, test marks, remarks.

Student Records

Instructors should ensure that the student develops and maintains a neat and accurate record of:

notes on theory
daily shop activities
project plans and records

Guidance and Vocational Information

Instructors must assume responsibility in their trade area and ensure that students and school guidance officials are aware of the local situation. It is advisable that instructors be active, interested and informed.

Achievement

The stress in our schools is QUALITY rather than QUANTITY. Instructors are responsible for ensuring that students are achieving to their capacity.

Use of Program Outlines

Instructors are expected to use the course outlines insofar as the shop accommodation and equipment permits. Experienced instructors may vary from this practice provided they can justify such variation to responsible officials.

METAL WORK 10

AN ORIENTATION COURSE

Specific Objectives

1. To teach and provide an opportunity for the students to practice the correct and safe procedures involved in operating the lathe, drill press, grinder and power saw.

2. To teach careful care of a machine tool - to keep it clean, oiled and in good running order.

3. To introduce the student to fine accurate measure-- ments and working to close tolerances.

4. To learn the different types of metal and their uses in regard to machine work.

5. To instil the fundamental and important need for properly ground cutting tools.

6. To instil in the student a pride in a job well done in a difficult medium.

7. To introduce simple blueprint reading so the student may follow a plan.

THE COURSE IN UNITS:

1. Introduction to the Metal courses.

2. Machine shop -
   - (a) Lathe
   - (b) The Drill Press
   - (c) The Grinder
   - (d) The Power Saw
   - (e) The Shaper (Optional)

3. Sheet Metal -
   - (a) Pattern Drafting
   - (b) Cutting, Shearing, Sawing
   - (c) Making holes
   - (d) Bending and Forming
   - (e) Soldering
   - (f) Fastening

4. Bench Work -
   - (a) Layout
   - (b) Cutting Stock
   - (c) Filing, Fitting, Finishing
   - (d) Hand threading

5. Shaping Metals - Hot and Cold

6. Heat Treating

COURSE CREDIT VALUES

METALWORK 10 - 5 credits

METALWORK 10 - 4 credits

NOTE: In both the 4 and 5 credit course the instructor should cover all units but make careful selection of the lecture and project work suggested.

METALWORK 10

UNIT ONE: INTRODUCTION TO THE METALWORK COURSES

Specific Objectives

1. To introduce students to the basic metal processing tools and machines.

2. To make known the opportunities in the metal trades, nationally, and locally.

3. To teach the elementary metallurgy of iron - the blast furnace and methods of refining.

4. To become familiar with the common alloys used in this year's work, be able to identify various common sheet metals and bar stock and know the characteristics of each.

Equipment and Operations

Machines and tools available in the shop other than those covered in subsequent units e.g. hammers, wrenches, pliers, screw drivers, etc. A collection of sheet, bar stock, and alloy samples. Throughout this course stress safety and good work habits.

Suggested Activities

1. Building up samples of various metals and alloys as a class project.

2. Student notebook. Every student should keep a careful record of the theory taught as well as plans and notes on each project. Commence a metal glossary.

References

American Iron and Steel Institute: THE PICTURE STORY OF STEEL

American Iron and Steel Institute: THE MAKING OF STEEL

Dep't. of Labour, Ottawa: CANADIAN OCCUPATIONS

Henry Ford Trade School: SHOP THEORY

Inland Steel Company: HOW STEEL IS MADE

S.D. of Winnipeg: RELATED SHEET METAL INFORMATION

UNIT TWO: MACHINE SHOP

A. LATHE:

Specific Objective

1. To become familiar with the lathe - its history, parts and care, size and capacity and safe use.
2. To gain some conception of the theory of metal cutting.
3. To do plain turning, between centers with reasonable accuracy.
4. To use three or four-jaw chucks and turn tapers using compound slide only.
5. To knurl, file, polish, and drill on the lathe.
6. To set for correct speed and feed.
7. To do spinning on the lathe (optional).

Equipment and Operations

Lathe, a good reference book, full set of turning tools - straight, right hand, left hand, parting, knurling; dogs with bent tail #1 to #6, dog plate, combination center drill and countersink, tool bits, sleeves and sockets to suit head stock and tail stock of lathe, three-jaw universal and four-jaw independent and jacob's chuck, ten inch long angle lathe file with handle, #0 and #000 emery cloth, crocus cloth, access to jobbers and taper shank drills, micrometers, calipers, center punch, combination set, scriber, speed indicator, spinning tools, and equipment.

Name essential parts of the lathe; clean and oil shop lathes every week (omit motors, these to be oiled by instructor or senior students); clear after each use; following a thorough demonstration to find center, center drill and set up between centers for plain turning, issue tool bits when all are familiar with lathe controls, check for alignment, set for speed and feed, set tool bit, turn to size, check for job expansion; set up in three or four-jaw chucks, face and turn taper with compound slide; knurl at least one project, file and polish, set for correct speed and drill at least one project. Emphasize safe operation for student and machines.

Suggested Projects

Bushing driver, center punch, nail set, paper punch, cast aluminum ash tray, screw driver, trammel points, bell center punch, plumb bob, surface gauge, toolmaker's clamp, automatic drift, hand vise.

References

Delmar: LATHE WORK

Feirer: GENERAL METALS

Henry Ford Trade School: SHOP THEORY

Petersen: 101 METAL WORK PROJECTS

Shell Oil Company: CHANGING THE SHAPE OF METALS WITH AN ENGINE LATHE

South Bend Lathe Company: HOW TO RUN A LATHE

Shuman: MACHINE SHOP WORK

B. THE DRILL PRESS:

Specific Objectives

1. To become acquainted with various types of drill presses, their care and safe use.

2. To learn parts of drill press and drills.

3. To realize the necessity of using the various holding devices.

4. To select the correct drill and to drill at the correct speed using lubricant when necessary.

5. To countersink.

Equipment and Operations

Twist drills and drill presses available, portable electric, breast, hand, drill press vises, straps, T-bolts, C-clamps, step blocks, V-blocks, parallels, angle plate, full set of straight shank drills, up to $\frac{1}{2}$", taper shank over $\frac{1}{2}$", twist drill gauge, sleeves, sockets, drifts, countersink, speed indicator, scriber, centre punch, and chisels.

Name essential parts of the twist drill and drill press, demonstrate use of holding devices, layout of hole, exercises on selection of tap drills and speed selection, kinds and use of coolants, stress safety precautions especially when drilling sheet metal. Demonstrate correct use of countersink if need arises in project; drawing hole into place.

Suggested Projects

Where required in sheet metal, bench or machine shop projects.

References

Delmar: DRILL PRESS WORK

Delta: GETTING THE MOST OUT OF YOUR DRILL PRESS

Feirer: GENERAL METALS

Shuman: MACHINE SHOP WORK

Tustison and Kranzusch: METALWORK ESSENTIALS

NOTE: This section is essential to Units 2, 3, and 4 so should be covered as the need arises.

C. THE GRINDER

Specific Objectives

1. To teach the theory of grinding and how to grind safely and correctly.

2. To know when and how to dress a wheel.

Equipment and Operations

Bench or pedestal only - wet and dry if available, goggles, various kinds of wheels and wheel dressers, speed indicator.

Stress safety by using eye protection and adjustment of tool rest; care of wheel - dress wheel and make clear the prevention of loading and glazing; how to remove and install a wheel, selection of proper wheel for work and speed of arbor.

References

Feirer: GENERAL METALS

Henry Ford Trade School: SHOP THEORY

Shuman: MACHINE SHOP WORK

Tustison and Kranzusch: METALWORK ESSENTIALS

NOTE: This section will apply to Units 2, 3 and 4 so cover when need arises.

D. THE POWER SAW:

Specific Objective

1. To know the kinds of power saws in common use with safe and correct use of those available.

Equipment and Operations

Available saws - band saw or hack saw, draw cut or push cut; mounting blade in saw correctly, check speed and regulate, if possible cut on wide side of thin stock, support outer end of long work, lock material securely in vise, check pressure for the blade used, adjust coolant on cut if available.

Suggested Projects

For cutting material over 1/8" thick in Units 2 and 4.

References

Delmar: BENCH WORK

Hesse: ENGINEERING TOOLS AND PROCESSES

E. THE SHAPER (OPTIONAL)

Specific Objectives

1. To know the kinds of shaper and names of main parts.

2. To teach the care and safe use of the tools and holding devices.

3. To use proper set up, speeds, feeds for straight shaping.

Equipment and Operations

Available shaper, vise, T-bolts, angle plate, hold downs, parallels, tool holders, tool bits.

Name the parts of the shaper, set up work correctly, test vise for squareness, adjust shaper for length and position of stroke, know correct speeds and feeds and adjust shaper accordingly, check for depth of cut, machine a flat surface. Stress safety.

Suggested Projects

Surface gauge, tool maker's clamp, screw driver, etc.

References

Delmar: SHAPER WORK

Henry Ford Trade School: SHOP THEORY

Feirer: GENERAL METALS

Shuman: MACHINE SHOP WORK

UNIT THREE: SHEET METAL

A. SHEET METAL PATTERN DRAFTING:

Specific Objectives

1. To use parallel line and radial line methods to develop stretchouts of projects and transfer these to metal.

2. To use measuring and marking tools used in sheet metal.

(It is not suggested that all drafting be taken at one time but rather as the need arises for a new project).

Equipment and Operations

Drafting boards, T-squares, compasses, dividers, drafting tape, scales, curves, scribers, punches, snips, circumference rule, sheet metal gauge, combination square, trammel points, protractors, marking gauge, straight edge.

Some time should be spent on the reading of blue prints to acquaint students with accepted practices. While developing patterns deal thoroughly with allowances for various hems, common seams, notches, rivets, and wire edges. Prepare full size development of projects on paper and transfer to metal - at least one project should be developed directly on the metal. Stress care and safe use of instruments.

Suggested Projects

Box, rectangular pipe, paint pail, funnel, rectangular elbow, round flaring pan, mail box, waste paper basket, dust pan, card holders, preserve funnel, rivet pan.

References

Delmar: MEASUREMENT AND LAYOUT

Dougherty: SHEET METAL PATTERN DRAFTING AND SHOP PROBLEMS

Ogilvie: SHEET METAL PATTERN DRAFTING MADE EASY

O'Rourke: SHEET METAL PATTERN DRAFTING MADE EASY

B. CUTTING, SHEARING AND SAWING SHEET METAL:

Specific Objectives

1. To select correct snips, shear, or saw blade.

2. To follow the line scribed on the metal so that the cut is accurate and no damage results to equipment or operator.

Equipment and Operations

Snips, - straight, combination, double cutting, circular, trojan; how to adjust snips and choose correct ones for jobs and capacity; use of shears - bench, squaring, others available.

Stress safety and capacity of each. Shearing with cold chisel in a vise, on a lead plate or end grain of hardwood block. Saw thicker gauges with hand hack saw. See Unit 4 (b).

Suggested Projects

Those listed in 3 (a).

References

Delmar: HAND PROCESSES

Delmar: MACHINE PROCESSES

Feirer: GENERAL METALS

Hesse: ENGINEERING TOOLS AND PROCESSES

Shuman: MACHINE SHOP WORK

Tustison and Kranzusch: METALWORK ESSENTIALS

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C. MAKING HOLES IN SHEET METAL:

(If Unit 2(b) The Drill Press has not been covered it should be done now).

Specific Objectives

1. To acquaint the student with methods of drilling and punching sheet metal correctly and safely.

Equipment and Operations

Variety of punches - solid, hand, hollow, center, lever - and capacity of each.

Punch holes for rivets in at least one project. Use hollow punch to get clearance for circular snips. Back up punch with lead plate or hardwood block when using solid or hollow punch. Drill holes for rivets in one project. Special precautions needed when drilling sheet metal.

Suggested Projects

Those of Units 2, 3 and 4.

References

Delmat: HAND PROCESSES

Dragoo: GENERAL SHOP METAL WORK

Feirer: GENERAL METALS

Tustison and Kranzusch: METAL WORK ESSENTIALS

D. BENDING AND FORMING SHEET METAL TO MAKE HEMS, COMMON SEAMS AND WIRE EDGES:

Specific Objectives

To give experience in making the seams, hems and edges needed in projects using hand and machine methods.

Equipment and Operations

Hand groovers, description and sizes, stakes, where and how to use them, use of wood mallet in forming, use and adjustment of bar folder, hand brake, roll former, beading machine, crimping machine, turning machine, burring machine, ring and circle shear.

Demonstrate the use and care of each machine and tool. Stress observance of each machine's capacity. Do each operation if possible by hand before using machines. Emphasize correct allowances for hems, seams and wire edges.

Suggested Projects

Those of Unit 3.

References

Broemel: SHEET METAL WORKERS' MANUAL

Delmar: HAND PROCESSES

Delmar: MACHINE PROCESSES

Feirer: GENERAL METALS

E. SOLDERING THE COMMON SHEET METALS:

Specific Objective

1. To give experience in soldering the various types of sheet metal using proper fluxes.

Equipment and Operations

Various types and weights of soldering coppers, gas furnaces, torches and jets, different kinds of solder and flux.

Recognition of various sheet metals, preparing and using the proper prepared flux, lighting jets and torches, ordering soldering coppers, temperatures for tinning and soldering, oxidation in soldering, effect of over heating the copper, composition of solders - bar, acid and resin core, tinning the iron, safety precautions in the use of hot copper and acid flux, sweat soldering, washing after soldering, shaping and reconditioning coppers.

Suggested Projects

Sample coupons, and projects of Unit 3.

References

Delmar: HAND PROCESSES

Dragoo: GENERAL SHOP METAL WORK

Feirer: GENERAL METALS

Henry Ford Trade School: SHOP THEORY

Hesse: ENGINEERING TOOLS AND PROCESSES

Tustison and Kranzusch: METAL WORK ESSENTIALS

F. FASTENING METAL:

Specific Objective

1. To acquaint students with, and to acquire some skill in performing the various methods of fastening metals and to become aware of the advantages of each.

Equipment and Operations

Rivet sets, hammers, rivets, P.K. Screws, screw drivers, stove bolts, soldering equipment, brazing and welding equipment (optional), sheet metal for cleats.

Sizes and kinds of rivets and self tapping screws depending on the gauge of the metal, recommended sizes of pierced and drilled holes for P.K. screws, sizes of stove bolts, drive and slip cleats, review of seams and soldering (hard and soft), rivet sets, screw drivers, riveting hammers. Introduction to brazing. Drill matching holes or punch for rivets and screws.

Suggested Projects

Those of Units 2, 3, 4 and 5 where fastening is required.

References

Ashcroft and Easton: GENERAL SHOP METAL WORK

Dragoo: GENERAL SHOP METAL WORK

Feirer: GENERAL METALS

Henry Ford Trade School: SHOP THEORY

Tustison and Kranzusch: METALWORK ESSENTIALS

UNIT FOUR: BENCH WORK

A. LAYOUT

Specific Objectives

1. To know and use layout tools and techniques in such a way that accurate work may be accomplished.

Equipment and Operations

Steel rule, steel tape, layout fluid, scriber, dividers, combination set, center and prick punch, ball pein hammer, steel square, inside and outside calipers, micrometers, bench plate, surface plat, angle plate, surface gauge, V-blocks, parallels, hermaphrodite calipers, bell cup punch, C-clamp.

Thorough demonstrations of the correct use of all tools and materials are necessary.

Suggested Projects

Inside and outside calipers, scratch gauge, dividers, pocket wrench, drill gauge, pocket square, bevel, screw gauge, brad hammer, marking gauge, depth gauge.

References

Delmar: BENCH WORK

Delmar: MEASUREMENT

Henry Ford Trade School: SHOP THEORY

Tustison and Kranzusch: METAL WORK

B. CUTTING STOCK AT THE BENCH

Specific Objective

1. To know hand hack saws, chisels, bench shears, and how to use them.

Equipment and Operations

Several types of hack saws, blades, chisels, and any shears available.

Since the proper use of the hand hack saw has proven to be one of the most difficult things to teach, great care must be taken to give a thorough demonstration and then check consistently for proper blade to use for the job, speed, tension of blade, holding techniques, and general procedure. Demonstrate the safe use of all four types of chisels and any bench shears available. Caution against attempting to cut hardened steel.

Suggested Projects

Those of Units 2, 3, 4, 5, and 6, where bench cutting is necessary.

References

Feirer: GENERAL METALS

Henry Ford Trade School: SHOP THEORY

Hesse: ENGINEERING TOOLS AND PROCESSES

C. FILING, FITTING AND FINISHING

Specific Objectives

1. To know files and other finishing materials and how to use them correctly and safely.

2. To know how to order finishing materials.

Equipment and Operations

Files - several lengths, shapes, types of cut, and degrees of coarseness; handles, file cards, soft jaws for vises, goggles, various types and grade of abrasive cloth and powder, buffing wheels.

Demonstrate correct use of files - cross filing and draw filing, using a tight-fitting handle. Keep file clean and free of pins. Store files separately. Finish by polishing project with successively finer abrasive cloth and then buff.

Suggested Projects

Those of Units 2, 4, and 5.

References

Feirer: GENERAL METALS

Henry Ford Trade School: SHOP THEORY

D. HAND THREADING:

Specific Objectives

1. To know the common types of threads and their parts.
2. To teach styles of taps and their use.
3. To be able to calculate tap drill sizes.
4. To make internal threads with a tap - open hole only and know the care necessary, choosing the best tap wrench.
5. To know the kinds of dies and die stocks and how to thread a rod.

Equipment and Operations

Complete tap set, various sizes and types of tap wrenches, screw stock, solid and adjustable dies if available, small square, tap drill chart, screw pitch gauge.

Exercises on determining tap drill sizes for various shapes of threads; drill hole and tap using correct procedure, check size and pitch required, check for squareness - ways of assuring square tapping. Caution against forcing tap. Prepare rod for threading, adjust dies if possible and cut threads to required length. Check it for fit and re-cut if necessary. Use cutting oil liberally.

Suggested Projects

Those done in Units 2 and 4.

References

Audel: MACHINISTS' HANDY BOOK

Feirer: GENERAL METALS

Henry Ford Trade School: Shop Theory

Tustison and Kranzusch: METAL WORK ESSENTIALS

UNIT FIVE: SHAPING METALS HOT AND COLD

Specific Objectives

1. To do cold shaping of metal bars, rods and pipes.
2. To know allowances for bending and twisting.
3. To teach types of forges, fuels, preparation of coke, kinds of tongs, the anvil, hammers, and anvil tools.
4. To be able to build a forge fire and heat work correctly.
5. To be able to draw out, upset, bend, twist, straighten and punch hot metal.
6. To do hot and cold cutting.

Equipment and Operations

Vise, hammers, lead hammers, wooden mallets, bending jigs, cutting tools, layout tools, wood or metal form for pipe bending.

Lay out lengths carefully, allowing for bends and twists, and shape cold. Start forge fire, heat ferrous metal and shape, cut and punch hot if necessary.

Suggested Projects

Hook and eye, chisels, punches, open end wrench, bolt blank, pin-up lamp, floor lamp, shelf bracket, C-clamp.

References

Feirer: GENERAL METALS

Harcourt: ELEMENTARY FORGE PRACTICE

Ilgen: FORGE WORK

Tustison and Kranzusch: METALWORK ESSENTIALS

UNIT SIX: HEAT TREATING

Specific Objectives

1. To teach the elementary theory of heat treating including annealing, hardening, tempering and case hardening.

2. To know the temperature associated with the use of metals.

Equipment and Operations

Forge, gas furnace, cast iron box, carburizing materials.

Brief explanation of the theory of heat treating, make oxidation color chart, anneal, harden and temper at least one project. Case harden one project.

Suggested Projects

Where needed in Units 2, 4, and 5.

References

Feirer: GENERAL METALS

Harcourt: ELEMENTARY FORGE PRACTICE

Henry Ford Trade School: SHOP THEORY

Ilgen: FORGE WORK

NOTE: "Pearlite" Casehardening Mixture, may be obtained in small quantities of ten to twenty pounds or more from spring servicing shops. This mixture consists of pea sized particles of carbon used for carburizing low carbon steel in a metal box in a furnace at a temperature of about 1650 to 1700 degrees F. This mixture will give good penetration in two hours, but will give a maximum penetration up to approximately .060 of an inch in four hours.

SHOP DRAFTING FOR METALWORK 10

The material for this course is either:

(a) As indicated, for first year shop students, in the curriculum drafting bulletin. Centers grouping students from various shops for drafting may wish to use this approach.

(b) As indicated on Page 49 of this curriculum bulletin, this outline is designed for centers where the metal instructor gives the drafting as an integral part of the metalwork course.

METALWORK 20

A VOCATIONAL METALWORK COURSE

THE COURSE IN UNITS:

1. Introduction and Related Information.

2. Machine Shop (a) Lathe (b) Drill Press
(c) Grinder (d) Shaper
(e) Power Saw (f) Milling Machine

3. Sheet Metal

4. Bench work

5. Forging

6. Molding

7. Welding

COURSE CREDIT VALUES:

METALWORK 20 - 8 or 10 credits.

NOTE: In centers offering Metalwork 10 for 5-credits it is recommended that Metalwork 20 receive 10 credits.

UNIT ONE: INTRODUCTION AND RELATED INFORMATION

Discussion of the place of metal in industry and further study of the requirements for and opportunities in various metal trades, both local and national.

Review manufacturing, uses and characteristics of tin plate, galvanized iron, Canada plate and black iron.

Review production, uses and characteristics of iron and steel. Grey, white and annealable cast iron, wrought iron, low, medium and high carbon steel.

Brief study of some of the steel alloys: components, characteristics and uses.

Sources of ores, methods of mining, refining, and uses of aluminum, copper, zinc, lead, and tin.

Theory of cutting; angles, speeds and feeds.

Lubricating and cutting oils.

Quality and uses of grindstones, hones and other abrasives.

Discussion of proper shop attitudes, qualities for foremanship, development of shop safety program, work of the Workmen's Compensation Board and National Safety Council.

This is not meant to be taken as a unit, but to serve as an introduction and an outline of related information adding to the student's general knowledge and attitudes.

UNIT TWO: MACHINE SHOP

Specific Objectives

1. To impart skill and safety measures in the use of the machines in the shop.

2. To stress the need for accuracy, careful set up, and working within close limits. Degree of accuracy is in the order of .002" and 1/64" for length.

3. To learn the shapes of cutting tools for various machines and the need for proper grinding; and to gain some experience in tool sharpening.

Equipment and Operations

A. LATHE: Review parts, maintenance, tools, theory of cutting, centre drilling, plain turning, taper turning with compound rest.

Taper turning - offset tailstock, taper turning attachment.

Internal tapers.

Boring, drilling, reaming and tapping.

Knurling.

Thread cutting - American Standard, external and internal on quick change and change gear lathes. Use of dial indicator.

Holding work in chucks, and on face plate.

Tools - shapes, clearance and rake angles.

Tool post grinding (optional).

Turning materials other than steel.

B. DRILL PRESS: Review work of Metal 10.

Types of drills.

Theory of cutting with drill.

Parts of drill, drill grinding for various metals.

Drilling, reaming, counterboring, spot-facing.

Speeds, feeds and coolants.

C. GRINDER: Review work of Metal 10

Grinding lathe and shaper tool bits.

Grinding drills.

Grinding other tools.

Tool post grinding on lathe (optional).

Grinding wheels: types, abrasives, bonds and speeds.

Mounting and truing grinding wheels.

D. SHAPER: Kinds, and uses.

Names of main parts.

Operation and safety.

Setting up and holding work.

Shaper tools.

Speeds and feeds.

E. POWER SAWS: Power hacksaws.

Horizontal and vertical bandsaws.

Main parts, care of machines.

Operation and safety.

Types of blades and cutting speeds.

F. MILLING MACHINE:

Recommended for Metalwork 30, but may be taken in Metalwork 20 for individual advanced students where work on project involves the use of this machine.

Suggested Projects

These are in the nature of tools, small machines or parts that involve several operations on one machine, or on several machines, or in more than one phase of the program. Casting and turning aluminum V pulley; machinists, C and bar clamps, bench vises, drill press vise, V-blocks, spindles, and similar projects.

References

Burghardt: PARTS 1 and 2. MACHINE TOOL OPERATION

Delmar: MACHINE SHOP SERIES

Knight, Roy E.: MACHINE SHOP PROJECTS

The Ford Trade School: SHOP THEORY

UNIT THREE: SHEET METAL

Specific Objectives

1. To increase skills in the use of hand tools and sheet metal machines.

2. To give further practice in sheet metal layout.

3. To increase understanding of principles involved in sheet metal pattern development.

Equipment and Operations

Machines and tools listed under Metalwork 10. More detailed study of parts and maintenance.

More advanced parallel and radial development.

Pittsburgh lock, double seam on cylindrical jobs, standing seams, hinges.

Raising.

Forming with die and press (optional).

Soldering and fluxes for various metals.

Metal spinning (optional).

Suggested Projects

Heating conductor elbow, camp stove, garage heater, water can, pail, medicine cabinet, tool box, garden cart, desk lamp, porch light, flower box, ornamental projects.

References

Broemel: SHEET METAL WORKERS' MANUAL

Daugherty: SHEET METAL PATTERN DRAFTING AND SHOP PROBLEMS

Delmar: SHEET METAL SERIES

Hobbs: WORKING WITH ALUMINUM

O'Rourke: SHEET METAL PATTERN DRAFTING

UNIT FOUR: BENCH WORK

This work is closely allied to the machine shop work.

Specific Objectives

1. To stress the need for careful and accurate interpretation of blueprints and accurate layout in production.

2. To develop skills in obtaining such accuracy.

3. To increase the skills in hand tool operation.

Tools and Processes

Layout work involving bench plate or surface plate, scriber, dividers, calipers, bevel protractor, surface gauge, square, angle plate, height gauge, parallels, prick and center punches, surface coatings.

Cold Chisels - kinds, uses, grinding.
Files - kinds, uses and manufacture.
Hacksaws - blades, speeds and pressure for sawing various materials.
Cutting threads with taps and dies. Pipe work.
Scrapers - types and uses.

This section need not be restricted to the use of steel as a medium. Projects using aluminum, aluminum alloys, copper, bronze and brass might be introduced with cold forming of bars and tubes.

UNIT FIVE: FORGING

Specific Objectives

1. To increase skill in working and shaping metal in the hot state.
2. To further safe practices in the handling of hot metal.
3. To observe the effects of heat treating steel.
4. To gain an appreciation of the place of forging in modern industry.

Equipment and Operations

Review of first year operations: bending, drawing out, upsetting, twisting, and shrinking; and in addition: splitting, punching holes in hot metal, and forge welding.

The use of sledge hammer, hardies, hot and cold chisels.

The processes of annealing, hardening, tempering and casehardening.

Discussion of modern forge practices.

Testing of iron and steel after various heat treatments.

Effects of carbon and other alloys on the properties of steel.

NOTE: Heat treating and casehardening may be taken separate from forging.

Suggested Projects

Welding eye-bolt, split eye-bolt, blacksmith's tongs, clevis, door knocker, frame for screw clamp, fire irons, foot scraper, grab hook, simple ornamental wrought iron lamps, tables, etc.

References

Smith: UNITS IN FORGING AND WELDING

Burghardt: MACHINE TOOL OPERATION (PART ONE)

Broemel: SHEET METAL WORKERS' MANUAL

UNIT SIX: MOLDING (OPTIONAL)

Specific Objectives

1. To introduce the student to the work of the foundry pattern shop.

2. To give the student experience in the safe handlihg of molten metal.

3. To know and identify some of the metals used in molding, their characteristics, and uses.

Equipment and Operations

Molding table, sand, flasks, furnace, crucible, crucible tongs, bellows, rammer, brushes, riddle, sprue and gate cutters, trowels, slicks, lifters, patterns, shrink rule.

Safety in operating furnace and handling and pouring molten metal.

Technical terms.

Brief outline of pattern making and industrial foundry procedures.

Preparing mold.

Preparing and pouring metal (aluminum and brass).

Removing and cleaning castings.

Casting metals, characteristics, uses, identification.

Suggested Projects

V-pulley, candlesticks, door knocker, house numbers.

References

Smith: UNITS IN PATTERNMAKING AND FOUNDING

UNIT SEVEN: WELDING (OPTIONAL)

Specific Objectives

1. To introduce the student to the field of welding and its relationship to other metal trades.

2. To give the student an opportunity to handle welding equipment.

3. To encourage safe practices in the operation of welding equipment.

4. To enable the student to join parts of projects by welding or brazing.

Equipment and Operations

Brief survey of the uses of oxyacetylene and electric arc welding.

Oxyacetylene:

1. Brief history of development of oxyacetylene equipment.
2. Care and operation of equipment.
3. Dangers involved and safety precautions.
4. Simple practice exercises in welding mild steel.
5. Brazing.

Electric Arc:

1. Type of machines: A.C. transformer, D. C. generator, A.C. generator, Selenium rectifier.
2. Care and operation.
3. Safety precautions.
4. Simple practice exercises on mild steel.

NOTE: The hazards of welding should be thoroughly explained and safe welding practices particularly stressed.

References

Air Reducation Co pany (Airco): OXYACETYLENE WELDING AND CUTTING INSTRUCTION COURSE LECTURES

The Lincoln Electric Company: LESSONS IN ARC WELDING

SHOP DRAFTING FOR METALWORK 20

See either second year outline in Curriculum Bulletin "Special Shop Drafting Outline"

OR

Follow outline as on Page 47 of this Bulletin

METALWORK 30

A VOCATIONAL METALWORK COURSE

THE COURSE IN UNITS:

1. Machine Shop
2. Sheet Metal
3. Bench Work
4. Forging
5. Welding

COURSE CREDIT VALUES:

METALWORK 30 - 10 or 15 credits

NOTE: 1. For 10 credit course select either Unit 1 or 2 and 3, 4, and 5.

2. For 15 credit course all units.

METALWORK 30

INTRODUCTION

The metallurgy of modern alloys and their significance must be brought home to the student. The place of the metal workers in local industry as well as industry abroad needs to be appreciated. It would be well to note the preparation needed, the working conditions that exist and the numbers needed by industry. Excursions are suggested wherever they bring such results.

A third year student should be able to elect any one or two phases of metalwork. Every opportunity should be taken to allow students to participate in a study of planning and setting-up a safe and efficient shop. The study of equipment should be an integral part of the course.

UNIT ONE: MACHINE SHOP

Specific Objectives

1. To provide machine shop practice.
2. To impart safe methods of operating the machines.
3. To develop prevocational skills.
4. To awaken in the student pride of workmanship.
5. To teach tool and machine maintenance of machines in the shop.

EQUIPMENT	OPERATIONS
A. Lathe	Threading with and without a dial indicator.
Taper attachment	Tapering. Fitting male and female. Boring and Threading. Calculating tapers by formula. Setting compound rest accurately.
	Knurling with and without power feed. Filing and power polishing.

Center and following rests	Long turnings and threadings.
Mandrels	Finish turning.
Lathe grinder	Grinding centers. Finishing hardened work. Centering and checking tapers. Indexing with carrige. Boring with job held on carriage.
B. Shaper	Adjust stroke and speed. Holding jobs. Bevel cuts, dovetails. Through shaping. Stopped keyways Cross V cutting vise jaws. Lining with a dial indicator.
C. Miller	Kinds of milling machines. Cutting keyways - name parts. Do end milling. Cutting slots. Mill a rack and gear. Indexing.
D. (i) Drill Press	Deep drilling. Coolants. Cast iron drilling. Countersinking. Counterboring. Holding. Alignment tapping. Engine finishing. Conditioning drills.
(ii) Power Handdrills	Sizes and speeds. Suitabilities and limitations.
E. Arbor Press	Pressing mandrels in and out of jobs. Assembling press fits. Installing or removing bushings.

Micrometer and vernier calipers	Accurate fitting.
Hole gauges	Drill checking.
F. Grinders	Bench. Flexible shaft. Surface grinder. Wheel grading. Dressing (diamond).

Suggested Projects

1. Lathe die holding jig.
2. A boring bar.
3. Vises: bench and drilling.
4. A bench grinder.
5. Clamps: Bar, "G", and jorgenson.
6. Peepsights.
7. Gyroscope.
8. Shop moving dolly.
9. Saw spindle.
10. Live center.
11. Fly tying vise.

References

Whipple and Baudik: ENGINE LATHE OPERATION

The Ford Trade School: SHOP THEORY. McGraw-Hill Company

South Bend Lathe Company: HOW TO RUN A LATHE

STARRET'S WALL AND POCKET CHARTS

STARRET CATALOGUE

UNIT TWO: SHEET METAL DEVELOPMENT

Specific Objectives

1. To correlate sheet metal with drawing, including developments by triangulation.
2. To outline trade opportunities.
3. To develop skills in hand and machine processes.

MACHINES:	PROCESSES
A, Bar folder	Adjust for gauge, width and scope. Make hems, wire edges and do partial bending.
B. Brake	Learn the kinds. Explore its uses. Stress its care and capacity.
C. Burring machines	Plan projects to utilize most of these.
Turning machines	
Wiring machines	
Crimping and beading machine	
D. Squaring shears	Adjustment.
E. Other available machines	

Suggested Projects

1. Tool box.
2. Tin cup.
3. Coal pail, copper Ash tray.
4. Watering can.
5. Funnels Offset, etc.
6. Measuring can with spout.

7. Garbage can

8. Duct work.

9. Eavestrough.

10. Three piece round elbows.

11. Roof flanges.

References

Daugherty: SHEET METAL PATTERN DRAFTING

Delmar: MEASUREMENT AND LAYOUT

Ogilvie: SHEET METAL PATTERN DRAFTING MADE EASY

Broemel: SHEET METAL WORKERS' MANUAL

UNIT THREE: BENCH WORK

Specific Objectives

1. To provide an opportunity to do elementary machine designing.

2. To advance the students' skill and confidence in hand shaping small machines from heavy metal.

3. To teach the needs for hand skills.

4. To teach accurate layout.

5. To gain first hand experience of the characteristics of various kinds of metal.

6. To give experience in estimating costs.

EQUIPMENT	PROCESSES
Lay out tools.	Laying out.
Hacksaws:	
Grinders:	Shaping.

Files, broaches.	Slotting.
Drills.	Drilling, Counterboring, Countersinking.
Reamers.	Reaming.
Taps and dies	Threading.
Chisels.	Chipping and shearing.
Surface Plate.	Scraping, lapping.

Suggested Projects

1. Depth gauges.
2. C clamps
3. Parallel clamps.
4. Small machines.
5. Bar clamps.
6. Trammel points.
7. Shop equipment.
8. Maintenance - repairs.

References

Bolinger: ELEMENTARY WROUGHT IRON

Giachino and Feirer: BASIC BENCH METAL PRACTICE AND PRECISION MEASURING

Smith, R. E.: UNITS IN BENCH METAL WORK

Trustison and Kranzusch: METALWORK ESSENTIALS

UNIT FOUR: HOT METALS

A. FORGING:

Specific Objectives

1. To appreciate forging in industry.

2. To experience man's increased power over metals by the use of heat.

3. To explore heat treating.

4. To differentiate further among the kinds of metal.

MACHINES AND TOOLS	PROCESSES
Forge	Note the kinds.
Fullers	Plan work to utilize these processes:
Swages	Hot punching and cutting.
Haries	Upsetting.
Sledges	Toolmaking including heat treatment: Hardening (a) water quench (b) oil (c) case
	Tempering
	Annealing

B. WELDING

Specific Objectives

1. To discover its increasing role in industry.

2. To discover talent.

3. To develop prevocational skills.

4. To extend possibilities in project making.

5. To indicate the breadth of learning needed.

6. To provide the necessary knowledge for safety, review carefully the hazards noted in Metal 20.

NOTE: Molding as outlined in Metal 20 may be used in support of machine shop and welding.

MACHINES	PROCESSES
Gas welding outfit.	Welding and cutting of light metals.
	Develop skill in running beads, with and without rods - forehand and backhand.

	Selection of tip, pressure and rods.
	Cast iron fusion welding.
	Brazing: iron, aluminum.
	Welding preparations.
	Distortion problems.
Arc welding.	Striking and controlling the arc.
A.C. and/or D.C.	Stringer beads no weave.
	Butt welds joining 3/16 mild steel and 3/8" V weld.
	Fillet welds.
	Cutting and hole making.
	Rod selection and classification.
	Polarity.
	Machine setting.
	Distortion problems.
	Comparison of A.C. and D.C.
	Selenium rectifiers.

Suggested Projects

1. Iron support roller.
2. Bicycle Racks.
3. Hand railing.
4. Coat racks.
5. Sheet metal stakes.
6. Basket ball hoops
7. Machine stands of anvil bases.
8. Welding or cutting table.
9. Swings.

References

Jennings, R.F.: GAS AND ARC WELDING AND CUTTING

Linde: WELDING AND CUTTING MANUAL

Zielke, Charles H.: ARC WELDING

SHOP DRAFTING FOR METALWORK

FOREWORD

The drafting for Metalwork 10 should cover fundamentals that would apply to any of the technical courses. In addition there will of necessity be some development using parallel line and radial methods.

Drafting for Metalwork 20 and 30 will stress procedures that apply more specifically to machine shop, sheet metal and bench work. Every student of Metalwork 20 and 30 should draw, ink and make an ozalid or blueprint for at least one project.

METALWORK 10 - DRAFTING

Specific Objectives

1. To develop good work habits resulting from careful planning.
2. To provide experience in the use of drafting tools and materials.
3. To give training in the reading of blueprints and the making of a working drawing.
4. Development of simple sheet metal stretchouts.
5. To appreciate the value of care in lettering and numbering.
6. To perform scale drawings.
7. To gain some experience in the use of various pictorial methods of drawing projects.

Suggested Plates and Applied Theory

1. Drafting tools and equipment - handling techniques and care.
2. Sheet layout for border, title block, blocking in drawing.

3. Lettering - vertical gothic letters in capitals only.

   (a) Plate #1 - I L T E F H

   N A X Y Z

   V W M K

   (b) Plate #2 - P R B J U

   C G O Q D S

   Numerals and fractions.

4. The working drawing.

   (a) Reasons for a plan.
   (b) How to read a working drawing.

      1. Conventional lines.
      2. Rules for dimensioning.

   (c) Drawing to scale.
   (d) Parallel, inclined lines, arcs, circles, tangents.
   (e) Kinds of drawings:

      1. isometric.
      2. orthographic projection.

5. Development of sheet metal stretchouts using:

   (a) parallel line.
   (b) radial line.
   (c) allowances for lap, grooved and double seam, rivets and wire edge.

METALWORK 20 - DRAFTING

1. Review:

   (a) Conventional lines.
   (b) Use and care of instruments.
   (c) Kinds of drawings.

2. Sectional views - full and half.

3. Assembly drawing.

4. Screw threads and fasteners.

5. Intersections.

6. Design as applied to metal.

7. Ozalid or blueprinting.

8. Allowances for sheet metal seams and hems.

METWORK 30 - DRAFTING

1. Review drafting for metalwork 10 and 20.

2. Develop an octagon, hexagon and ellipse.

3. Sheet metal patterns for all Metalwork 30 projects.

4. Symbols - steel, cast iron, bronze, brass, copper, aluminum, white metal, zinc, lead, babbitt, breaks, internal and external threads, gas and arc welds, fire line, gas line, etc.

5. Abbreviations - wrought iron, galvanized iron, on center, center line, center to center.

6. Gears and parts.

7. Blueprinting.

8. Heating layout.

9. The architect and his services.

B I B L I O G R A P H Y

REFERENCES:

Alexander and Street: METALS IN THE SERVICE OF MAN
Pelican Books - Penguin Books, 245 Fifth Avenue, New York

A very good low priced book dealing with the production and metallurgy of the common metals of industry, so written that it is interesting reading for the layman as well as for metalwork students.

Audel: MACHINISTS' AND TOOLMAKERS' HANDYBOOK

A very good reference with sections on mathematics, physics, and drafting.

Bick, A.F.: ARTISTIC METALWORK, Bruce Publishing Company

Burghardt and Axelrod: MACHINE TOOL OPERATION, PART I, Toronto, McGraw-Hill Company, 1953.

Daugherty: SHEET METAL PATTERN DRAFTING AND SHOP PROBLEMS, Toronto, McGraw-Hill Company, 1954.

Dragoo and Dragoo: GENERAL SHOP METALWORK

Metallurgy, bench metal, art metal, ornamental and sheet metal with projects on each. Good elementary books.

Harcourt: ELEMENTARY FORGE PRACTICE

Very good. 38 projects with procedure steps. Metallurgy and heat treating well covered.

Hesse: ENGINEERING TOOLS AND PROCESSES

Complete with questions and problems on each chapter but somewhat advanced for Metalwork 10. Good reference.

Hobbs: WORKING WITH ALUMINUM, Bruce Publishing Company

Jennings, R.F.: GAS AND ARC WELDING AND CUTTING

This clearly organizes the elementary steps in gas welding.

Kugler, H.L.: ARC WELDING LESSONS FOR SCHOOL AND FARM SHOP, The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

An excellent book on Arc Welding theory and operations particularly on vertical and overhead welding. Contains some farm projects.

Ogilvie: SHEET METAL PATTERN DRAFTING MADE EASY

Many projects with directions. Tables, soldering data and much other useful information. A good reference.

O'Rourke: SHEET METAL PATTERN DRAFTING, McGraw-Hill Company

Shuman: MACHINE SHOP WORK

A machine shop text. Well illustrated, questions and answers on each chapter.

Smith, R.E.: UNITS IN BENCH METAL WORK

This is a simple small understandable booklet on tools, cold forging and art metal.

Smith, R.E.: UNITS IN FORGING AND WELDING

This is a simple summary of each.

Smith, R.E.: UNITS IN PATTERNMAKING AND FOUNDING, McNight and McKnight Publishing Company

Smith, R.E.: UNITS IN SHEET METAL WORK

This is a skilful summation of the most important sheet metal theory and practice, hand and machine.

Tustison and Kranzusch: METALWORK ESSENTIALS

This is a fairly complete elementary coverage of general metals, practices, and tools. It is well illustrated, readable as a student text, and includes questions.

Wagener and Arthur: MACHINE SHOP THEORY AND PRACTICE, D. Van Nostrand Company, Toronto, Ontario

Wagener and Arthur: WORKBOOK ON MACHINE SHOP THEORY AND PRACTICE, D. Van Nostrand Company, Toronto, Ontario.

Whipple and Baudik: ENGINE LATHE OPERATION

This is a good machine shop guide with projects, suitable for student use.

Ziekle, Charles H.: ARC WELDING

This is a complete elementary course in arc welding to be recommended for student use.

OTHERS:

THE FORD TRADE SCHOOL SHOP THEORY

This is a large expensive teacher's reference in machine shop. It is comprehensive, well illustrated and recent.

THE STARRET CATALOGUE

Has a section of valuable metal data as well as illustrating the tools.

Air Reduction Company (Airco): OXYACETYLENE WELDING AND CUTTING INSTRUCTION COURSE LECTURES

Linde Air Products Company Ltd.: THE OXYACETYLENE HANDBOOK

A Manual on Oxyacetylene Welding and Cutting Procedures. A very good reference book on procedures and applications of gas welding on all weldable metals.

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